CHICAGO NEUROLOGICAL SOCIETY.

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The Vice-President, Dr. H. H. Donaldson, in the chair.

Structure of Neuroglia.—Dr. G. Carl Huber, of the University of Michigan, reported observations of his, extending over a series of years, embracing a study of neuroglia tissue of different classes of vertebrates, made especially with the Benda's sulpha-lizarate toluidin blue method. The research was undertaken with a view of harmonizing the various views expressed concerning the structure of neuroglia tissue and of obtaining data which must of necessity be at hand in order that experimental work involving structural changes in the neuroglia tissue might be undertaken. The report embraced observations made on the neuroglia tissue of man, dog, cat and rabbit among the mammals; dove, tortoise and frog, in all of which the neuroglia tissue of the white matter of the spinal cord was especially considered, since it was found that the relation of the structural elements of this tissue might here be more clearly made out, and its relation to other structures more exactly defined. The results obtained were controlled by observations on the gray matter of the spinal cord and brain.

The following general conclusions were reached: The neuroglia tissue of all vertebrates consists of neuroglia cells and neuroglia fibers. The cellular elements vary greatly in size and shape, depending in the main on the spaces which they occupy. In the majority of the neuroglia cells a granular cytoplasm can be clearly made out. This varies greatly in amount, at times forming only a narrow zone around the nucleus; again present in much larger quantity and presenting very distinct protoplasmic branches. In certain cells, which are designated as "free nuclei," no distinct cytoplasmic covering can be seen. The nuclei of neuroglia cells vary in size, shape and structure. The majority of them may be spoken of as vesicular nuclei with chromatin in the form of a number of relatively large granules, variously disposed. Other nuclei, usually the smaller and smallest seen, present the appearance of compact masses of chromatin, taking the stain relatively deeply. Transition forms between the two varieties of nuclei specially mentioned may readily be made out. The neuroglia fibers show very definite relation to the neuroglia cells, being imbedded in the peripheral layer of their protoplasm. With the method used, whenever the preparation is properly differentiated, the neuroglia fibers could be traced through the protoplasm of neuroglia cells without interruption. In imperfectly differentiated preparations, they often appeared as processes. The small, deeply-stained "free nuclei" and the free nuclei showing a vesicular structure, show no definite relation to neuroglia fibers, and are looked upon as undifferentiated and undeveloped neuroglia cells.

Microscopic preparations substantiating the statements made were demonstrated.

The Mesoblastic Origin of the Neuroglia Tissue.—Dr. Shinkishi Hatai, from the Neurological Laboratory of the University of Chicago, reported upon the origin of this tissue. He said: On examining the cross sections of the central nervous system of the white rat and mouse, two kinds of nuclei, differently characterized, are easily recognized. One kind coincides in structure with that found in the nerve cells, while the other resembles very much in size, shape and staining character, and in an internal structure, the nuclei found in the walls of the capillaries. These nuclei, so called, are always surrounded by a small amount of cytoplasm. These facts led the writer to a systematic study of these structures in order to determine their origin within the central nervous system.

For the investigation new-born white rats and mice were used. The tissues were fixed in Carnoy's mixture, and the paraffin sections were made and stained with toluidin blue and erythrosin.

One group of the nuclei, which resembles in structure as well as in shape those of the nerve cells, can be identified without difficulty as derived from the ectoblast. For convenience, Dr. Hatai called these nuclei Type I. The identification of the other group of the nuclei, or Type II, is, however, difficult, since these nuclei have no similarity to the nuclei of the ectodermal derivatives. On examining the capillary wall, he noticed very frequently a nucleus projecting outwards, and in some cases these nuclei were isolated from the capillary wall but lay close to it. Between these two appearances various intermediate stages could be easily found. In some cases a tip of the nucleus is still attached to the capillary wall while the rest of it has become separated. This appearance shows very plainly the migration of the nucleus from the capillary wall into the surrounding tissue. There is no danger of confusing these nuclei with those of the leucocytes which escape from the capillary wall and exhibit ameboid movements, since they differ from them both in structure and size: the former being very must larger than the latter. As soon as the nuclei are separated from the capillary wall they migrate away from the capillary.

The following observation is in favor of the above conclusion. A large number of the mitotic figures in various phases are often visible in the nuclei of the capillary wall. In such a locality where the mitoses are abundant the nuclei are so closely placed that in some cases the one nucleus overlaps the others, the outermost nucleus projecting outwardly, thus showing the first step of the migration.

From the above Dr. Hatai thinks there is no doubt that the nuclei which he has called Type II have been derived from the capillary wall and migrated away from it. The identification of these nuclei which have migrated from the capillary wall with neuroglia nuclei is difficult. Since it has been shown that a small amount of connective tissue is present in the central nervous system in both young and old animals, this connective tissue might have been formed by the nuclei described, but there is no evidence to support the view that this could occur. The large number of nuclei which have migrated from the capillary walls suggests at once that some of the neuroglia tissue is supplied by these nuclei. This idea is favored by the fact that similar neuroglia nuclei to those migrated from the capillary wall or mesodermal in type, exist in the adult animal.

According to Kühne and Chittenden, the neuroglia fiber is produced by the chemical transformation of cytoplasm into neurokeratin. Chavalier further showed that the same chemical substance exists also in the medullary sheath of the peripheral system. The presence of the neurokeratin meshwork in the peripheral nerve has been shown by histologists also. If it is true that the entire medullary sheath in the peripheral system is formed exclusively by the mesoblastic cells, one can assume that there is here a chemical transformation of mesoblastic cytoplasm into structures characteristic of ectodermal cells. This evidence favors Dr. Hatai's hypothesis that the nuclei which have migrated from the capillary wall might be transformed into the neuroglia tissue and give rise to neurokeratin. Since we have no evidence that Weigert and Benda's technic brings out the neuroglia fibers of ectodermal origin only, these methods can hardly touch the point mentioned above. Dr. Hatai therefore concludes at the present moment that the nuclei which migrate from the capillary wall into the central nervous system are one source of the neuroglia tissue. The reasons for this conclusion may be summarized as follows:

(1) The great number of these nuclei; (2) neurokeratin may be formed not only by the cytoplasm of the ectodermal cells, but also by the cytoplasm in mesodermal cells; (3) presence of the nuclei of mesodermal type in the central nervous system of the adult animal; (4) ordinary connective tissue nuclei present in the central nervous system are there in much smaller numbers than the nuclei which have migrated from the capillary walls; (5) there is no evidence that the neuroglia fibers stained by the modern neuroglia technic are of ectodermal origin only; (6) since the cytoplasm undergoes very easily morphological and structural alterations while the nucleus is more resistant, it follows that the nuclei are the better indication of the genetic relationship of the cells; (7) Capobianco and Fragnito, who observed the nuclei which migrate from the meninges into the central nervous system and believe these nuclei form a part of the neuroglia tissue, were unable to trace the successive transformations of the former to the latter. This observation of Capobianco was made on the spinal cord of *Mus decumanus.*